

BELLCOMM, INC.

1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: CSM Configurations to
Support Saturn V Workshops**DATE:** March 5, 1968**FROM:** J. J. Gabrik
W. W. HoughABSTRACT

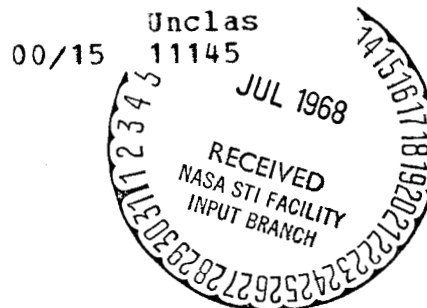
A presentation on CSM configurations for support of Orbital Workshops launched by Saturn V's was given by the authors to C. W. Mathews on February 13, 1968. Configurations of CSM's used with the Saturn 1B Workshop were reviewed. The AAP-3A baseline CSM, with the same functional requirements that exist in the AAP-3A mission, was chosen as one spacecraft in the subject study. The same hardware configuration, loaded with enough consumables for only a four-day independent capability, was the second configuration studied. A third configuration used Block II as a base in defining a logistic CSM that served the same functions as the second, or AAP-3A derived logistic CSM.

Performance margins were determined for the three configurations as a function of altitude and inclination. Maximum payload capabilities for both ascent and return phases

(NASA-CR-95451) CSM CONFIGURATIONS TO
SUPPORT SATURN 5 WORKSHOPS (Bellcomm, Inc.)
25 p

N79-72083

FF No. 602(A)	100-95451	(THRU)
	(PAGES)	(CODE)
	(NASA CR OR TRN OR AD NUMBER)	(CATEGORY)
	AVAILABLE TO NASA OFFICES AND NASA RESEARCH CENTERS ONLY	



BELLCOMM, INC.

1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: CSM Configurations to
Support Saturn V Workshops**DATE:** March 5, 1968**FROM:** J. J. Gabrik
W. W. HoughMEMORANDUM FOR FILEINTRODUCTION

A presentation on CSM configurations for support of Orbital Workshops launched by Saturn V's was given by the authors to C. W. Mathews on February 13, 1968. This memorandum includes the view-graphs used as figures for support of the text. Figure 1, the introduction to the presentation, lists the three configurations studied and the items considered in the analysis.

REVIEW OF CSM CONFIGURATIONS FOR THE SATURN 1B WORKSHOP

The current AAP schedule lists six CSM's for use with the Saturn 1B Workshop. The first CSM, designated AAP-1, performs the 28-day Workshop-activation mission. AAP-3A, the second CSM, will revisit the Workshop to obtain medical data on long-duration manned space flight. The third CSM, AAP-3, must rendezvous with the AAP-4 LM-ATM to man it before rendezvousing with the Workshop. Three additional CSM revisit missions, designated AAP-5, 6, and 7, will reactivate the ATM and conduct other Workshop experiments. Except for AAP-1, all CSM missions have a planned duration of 56 days.

Changes to the Apollo Block II CSM's to meet the above mission requirements are accomplished by kits. These kits modify, delete, or add components or subsystems to the CSM. Definition of kit requirements is underway at MSC and NAR. At this time, 32 kits have been identified for AAP-1, 36 kits for AAP-3A, 5, 6 and 7, and 37 kits for AAP-3. There are 23 kits listed in Figure 3 that apply to all the CSM's. The major differences in the kit assignments as shown in Figure 4 are: (1) AAP-1 CSM uses 15 Block II cryogenic storage tanks and the other five CSM's use 7 new AAP tanks. (2) These tank differences are also reflected in the kits for wiring, structure, and displays and controls. (3) The AAP-3 CSM uses a solid retro pack for the backup deorbit function, but the other CSM's use RCS for this function. (4) Except for AAP-1, all CSM's have a deorbit battery for backup in the event of complete fuel cell failure.

The weight for each CSM varies with the mission duration, the required support functions, and the required kit modifications. Presently, the 28 day AAP-1 mission has a positive payload margin of approximately 2700 lbs. The 56-day single-rendezvous missions (AAP-3A, 5, 6 and 7) show an estimated positive margin of 680 lbs. AAP-3, because of its dual rendezvous requirement, has an estimated performance deficit of 1350 lbs. Figure 5 presents the major differences in CSM requirements for the single-rendezvous AAP-3A mission and the dual rendezvous AAP-3 mission, and gives resulting weight differences.

CSM CONFIGURATIONS FOR SATURN V WORKSHOPS

Three CSM configurations for use with ground-equipped Workshops have been analyzed from the weight and performance standpoint. Two and 2 1/2 stage launch vehicle capabilities for 87 x 120 nautical mile (NM) initial orbits at inclinations between 30° and 50° were compared to CSM inserted weights. The CSM weights include SPS and RCS propellants for Hohmann transfer to, and rendezvous with, the Workshop at final circular orbits between 230 and 270 nautical miles altitude. In all cases, SPS propellant is included for prime deorbit, and RCS propellant is included for back-up deorbit.

The format of the presentation is identical for the three configurations studied, - four figures are used for each. The first figure in each set describes the functions assigned to the CSM, and includes a brief listing of the modification kits incorporated in the configuration. The second figure is a weight statement for the configuration, but does not include SPS and RCS propellants; propellants are a function of final altitude.

The third figure in each set shows the weight and performance data in graphical form. The solid sloping lines give the launch vehicle capability for 87 x 120 NM insertion vs. inclination. These lines are identical for all configurations. The higher line is for a 2 1/2 stage insertion; SPS flight performance reserve has been subtracted to allow a consistent comparison with the CSM weights that include only the propellants required after insertion. The lower line is for 2 stage insertion; the SLA is subtracted from total capability to allow comparison with just the CSM weight. These figures also show the CSM weights, including propellants for the specified altitude. There is no RCS propellant for Workshop attitude control included in these values. When a dashed (weight) line is below a solid (capability) line, there is a performance margin equal to the difference. However, if the dashed line is above the solid line, a performance deficit exists. The fourth figure in each set gives the same data in chart form. Total CSM weight is compared with launch vehicle capability to give numerical values of performance margins (or deficits).

The three configurations analyzed are:

(1) AAP-3A Baseline (Figures 6, 7, 8 or 9)

This configuration was chosen for the case where the CSM is to play an active part in the mission. Its functions are identical with the revisit mission to the present Saturn IB Workshop. It provides the consumables necessary to maintain itself, the Workshop, and the crew for 56 days under the same ground-rules that are used in the present program (i.e., the Workshop provides CSM power requirements in excess of 1800 watts, a molecular sieve for CO₂ control, attitude control of the cluster, etc.) Dry weight and consumable loadings are identical to the 3A configuration. A two stage insertion gives positive performance margins only at the lower ends of the altitude and inclination ranges. A 2 1/2 stage insertion, however, gives positive margins over the entire range of altitudes and inclinations considered.

(2) AAP-3A Derived Logistic CSM (Figures 10, 11, 12 and 13)

This configuration uses the identical hardware as specified in the above case. It is loaded with consumables to provide only a four-day independent capability. The CSM is placed in a state of minimum activity after docking, and the Workshop provides all its in-orbit requirements. These are identified in Figure 10. This configuration was analyzed because the hardware will be the same for four of the early AAP missions (3A, 5, 6 and 7), and the same vehicle could be used in the logistic function (i.e., the continued use of a standard CSM.) Although positive performance margins exist for the entire ranges of altitudes and inclinations, higher margins are obtained by developing a logistic CSM from Block II.

(3) Block II Derived Logistic CSM (Figures 14, 15, 16 and 17)

This configuration has the identical functions as the preceding one, and will require approximately the same support from the Workshop. However, kits required to extend duration in the 3A configuration are not included. The only major addition in the list of Figure 14 is the RCS tank farm kit. Although only one farm (in addition to Block II tankage) is required for the RCS propellants included in the CSM weights, two farms are added to provide tankage for fuel that might be required for Workshop pointing and control. The performance margins for this configuration are very high. The 270 NM, 50° case gives a minimum margin of over 5500 pounds.

ASCENT AND RETURN PAYLOAD CAPABILITIES


The SPS and RCS propellant quantities included in the Figures of the last section were based on the CSM weights. Where a margin exists, one would expect that margin to be used for additional payload. However, some of that payload must be propellant.

Therefore, the total propellants required if the CSM inserted weight (including the propellants) is equal to the insertion capability were calculated (2 stage insertion only). These propellant weights were then subtracted from the capability, and the results are shown in Figure 18. Comparison with the three CSM weights (without propellants) gives the actual net payload capability. For instance, the net payload capability for a Block II derived Logistic CSM is, from Figure 18, about 4600 pounds at 50° , 270 NM. The margin for this case without additional payload was over 5500 pounds.

Maximum return payload capabilities are given in Figure 19. The values, in the neighborhood of 1000 pounds, are based on transferring all portable equipment not required in the deorbit phase to the Workshop. Figure 19 itemizes the steps followed in obtaining the return payload capability.

ACKNOWLEDGMENT

The authors wish to acknowledge the support of K. E. Martersteck, P. H. Whipple and I. Hirsh. Their work led to the launch vehicle capabilities and propellant requirements given.


J. J. Gabrik


W. W. Hough

1022-JJG
WWH-ms

CSM CONFIGURATIONS TO SUPPORT SATURN V WORKSHOPS

- CONFIGURATIONS
 - AAP-3A BASELINE
 - AN ACTIVE VEHICLE
 - A LOGISTICS VEHICLE
 - LOGISTIC CSM DERIVED FROM BLOCK II
- ANALYSIS
 - FUNCTIONS
 - CSM KITS REQUIRED
 - WEIGHT
 - PERFORMANCE MARGINS
 - 2 STAGE INSERTION
 - 2 1/2 STAGE INSERTION
 - ADDITIONAL PAYLOAD CAPABILITIES
 - RETURN PAYLOAD CAPABILITIES

MLS

FEBRUARY 13, 1968

FIGURE 1

AAP CSM MODIFICATIONS

REASONS FOR CSM MODIFICATIONS

- MISSION DURATION
- CLUSTER SUPPORT
- CLUSTER CONSTRAINTS
- DUAL RENDEZVOUS

BLOCK II MODIFICATIONS BY KITS

AAP-1	32 KITS
AAP-3A, 5, 6, 7	36 KITS
AAP-3	37 KITS

FIGURE 2

AAP CSM MODIFICATION KIT SUMMARY

MODIFICATIONS TO BLOCK II

APPLICABLE TO ALL CSM'S
AAP-1, 3A, 3, 5, 6, 7

ATMOSPHERE CONTROL (2 GAS)	A3
WATER STERILIZER & H ₂ SEPARATOR	A6
THERMAL MANAGEMENT & ECS RADIATOR	A7, A8
UPDATED FUEL CELL & VOLTAGE REGULATOR	E4, E1
CM UMBILICAL	E2
FOURTH ENTRY BATTERY (REPLACE PYRO)	E5
IMU COOLANT BYPASS	N2
AUGMENTED RCS (2 TANK FARMS)	P2
SPS TANK REMOVAL & SYSTEM UPGRADING	P4, P1
CLUSTER AUDIO, CAUTION & WARNING	T1, T11
VHF, VOICE, DATA, SIGNAL COND, TLM	T2, T3, T7
UPDATA LINK EXPANSION	T6
DELETE HIGH GAIN ANTENNA & RENDEZVOUS TRANSPONDER	T9, T10
VHF RANGING & ANTENNA, RELOCATION	T12, T14
TELEPRINTER	T13

FIGURE 3

AAP CSM MODIFICATION KIT SUMMARY

KIT DIFFERENCES

MODIFICATIONS TO BLOCK II	AAP-1	AAP-3A, 5, 6, 7	AAP-3
URINE & WASTE WATER DUMP		A4, A5	A4, A5
REDUNDANT BATTERY CHARGER		E3	E3
RETURN BATTERY PACK		E6	E6
CRYOGENIC STORAGE (O_2, H_2, N_2)	E7, BLK II TANKS	E8 - 7 AAP TANKS	E8 - 7 AAP TANKS
SM & CM WIRING CHANGES	E9, E10	E11, E12	E11, E12
SOLID RETROPACK (PHOENIX)			P3
CM DISPLAYS, CONTROLS, CAUTION & WARNING	T4, T8	T5, T8	T5, T8
WASTE MANAGEMENT KIT			X12
SM & CM STRUCTURAL CHANGES	X7, X8	X9, X10	X9, X10
PLSS (2)	X3	X3	
EXPERIMENT STORAGE	X1	X"?"	X2

FIGURE 4

SUMMARY OF AAP-3A & AAP-3 DIFFERENCES

3A Δ TO 3

SINGLE RENDEZVOUS REQUIREMENT

• OFFLOAD RCS PROPELLANT & TANKS	-2680#
• OFFLOAD SPS PROPELLANT	- 700

NO LM OR LM/MDA INTERFACE

• ADD O ₂ TO SM (FROM LM)	+1200
• DELETE LM AND LM/MDA LEAKAGE	- 300
• ADD 2 PLSS UNITS IN CM (FROM LM)	+ 150

DEORBIT BACKUP CHANGE

• REMOVE SOLID RETRO PACKAGE	-1300
• ADD RCS PROPELLANT AND TANKS	+1600

3A Δ TO 3	-2030#
-----------	--------

AAP-3 WEIGHT MARGIN	-1350#
3A WEIGHT IMPROVEMENT	2030
AAP-3A WEIGHT MARGIN	+ 680#

FIGURE 5

AAP-3A CSM CONFIGURATION

FUNCTIONS

- DEORBIT BACKUP OF SPS BY RCS
- SINGLE RENDEZVOUS
- CSM FCP LEVEL OF 1800 WATTS
- SUPPLY AND MAINTAIN A CLUSTER TWO GAS ATMOSPHERE
- SUPPLY 56 DAYS OF FOOD
- SUPPLY 28 DAYS OF LIOH

BLOCK II KIT MODIFICATION SUMMARY

- REMOVE SPS STORAGE TANKS & 1 HELIUM TANK
- REMOVE BLOCK II CRYO TANKS & ADD 7 AAP CRYO TANKS
- ADD 2 RCS TANK FARMS
- ADD CONTROLS FOR 2 GAS ATMOSPHERE
- ADD RETURN BATTERY AND REPLACE RE-ENTRY PYRO BATTERY
- UPRATED FUEL CELLS
- ADD AUDIO HARDLINE AND CLUSTER CAUTION AND WARNING
- DELETE LM TRANSPONDER AND HIGH GAIN ANTENNA
- ADD INSTRUMENTATION, WIRING, REGULATORS, DISPLAYS AND CONTROLS AS REQUIRED
- ADD WASTE WATER DUMP, WATER STERILIZER, HEATERS, BLANKETS
- ADD 2 PLSS UNITS

FIGURE 6

AAP-3A BASELINE WEIGHT STATEMENT

(LESS PROPELLANTS)

CM 14030

EMPTY 11620

NON-EXPENDABLE LOAD 2109

CREW SYSTEMS	1607
RCS RESIDUAL	45
ECS	307
EXPTS, SUPPORT	150

EXPENDABLE LOAD 301

RCS	225
ECS	76

SM 15854(+PROPELLANTS)

EMPTY 11143

NON-EXPENDABLE LOAD 840

RCS RESIDUAL	208
SPS RESIDUAL	562
CRYO RESIDUAL	70

EXPENDABLE LOAD 3871 (+PROPELLANTS)

SPS	}	PROPELLANTS FUNCTION OF ALTITUDE, INCLINATION, EXPT. REQUIREMENTS.
RCS		
O ₂		3283
H ₂		225
N ₂		363

AAP-3A BASELINE CSM WEIGHT

29884 (+PROPELLANTS)

FIGURE 7

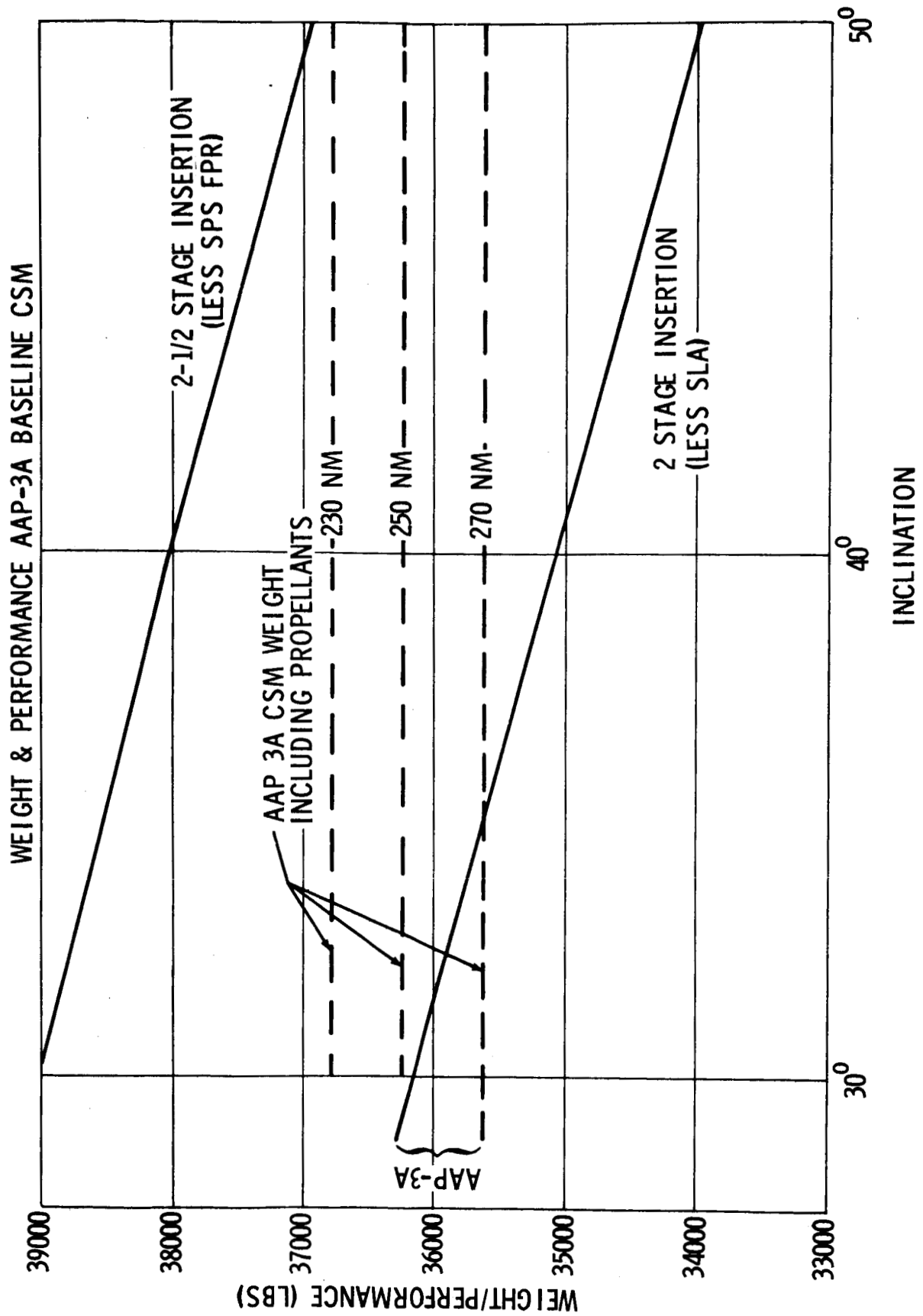


FIGURE 8

AAP-3A BASELINE WEIGHT & PERFORMANCE

CSM WT. WITHOUT PROPELLANTS 29884				MODE		2 STAGE			2 1/2 STAGE		
FINAL ALTITUDE	PROPELLANTS		CSM INSERTED WT	CAPABILITY *	INCLINATION	30°	40°	50°	30°	40°	50°
	SPS	RCS									
230 NM	3194	2530	35608**			+542	-558	-1658	+3392	+2392	+1292
250 NM	3644	2698	36226			- 76	-1176	-2276	+2774	+1774	+ 674
270 NM	4063	2830	36777			-627	-1727	-2827	+2223	+1223	+ 123

* 2 STAGE LAUNCH VEHICLE CAPABILITY HAS SLA SUBTRACTED

2 1/2 STAGE LAUNCH VEHICLE HAS 1150 LB SPS FPR SUBTRACTED

** AAP-3A MISSION AT 28.86° INCLINATION, 230 NM ALTITUDE, WITH 2 STAGE INSERTION GIVES MARGIN OF 40200-3915-35608 = 677 LB.

FIGURE 9

AAP-3 A DERIVED LOGISTIC CSM

FUNCTIONS

- SINGLE RENDEZVOUS
- DE-ORBIT BACKUP OF SPS BY RCS
- FOUR-DAY INDEPENDENT CAPABILITY
 - POWER
 - UPRATED FUEL CELLS FOR ASCENT AND RENDEZVOUS
 - BATTERIES FOR DE-ORBIT
 - LIFE SUPPORT
 - FOOD, LIOH, ETC. FOR 4 DAYS
 - PURE O₂ ATMOSPHERE
 - WATER FROM FUEL CELLS
 - GASEOUS O₂ SUPPORT FOR DE-ORBIT
- OWS SUPPLIES ALL CSM IN-ORBIT REQUIREMENTS
 - POWER (1-2 KW)
 - CONTINUOUS HEATER AND SYSTEM STANDBY
 - INTERMITTENT CSM STATUS MONITORING (INSTRUMENTATION, C & D, TELEMETRY)
 - LOW-DUTY-CYCLE OPERATION OF SUBSYSTEMS WHICH EXHIBIT DEGRADATION WITH NON-OPERATION
 - ATMOSPHERE CIRCULATION AND LEAKAGE MAKEUP WHEN CSM IS OPEN TO OWS
 - CRITICAL CSM SUBSYSTEM WARNING PANEL
- CSM ORBITAL LIFETIME
 - INDEPENDENT OF CSM CONSUMABLES
 - DEPENDENT ON SYSTEM DEGRADATION, WEAROUT

BLOCK II KIT MODIFICATION SUMMARY

- REMOVE SPS STORAGE TANKS & 1 HELIUM TANK
- REMOVE BLOCK II CRYO TANKS & ADD 7 AAP CRYO TANKS
- ADD 2 RCS TANK FARMS
- ADD CONTROLS FOR 2 GAS ATMOSPHERE
- ADD RETURN BATTERY AND REPLACE RE-ENTRY PYRO BATTERY
- UPRATED FUEL CELLS
- ADD AUDIO HARDLINE AND CLUSTER CAUTION AND WARNING
- DELETE LM TRANSPONDER AND HIGH GAIN ANTENNA
- ADD INSTRUMENTATION, WIRING, REGULATORS, DISPLAYS AND CONTROLS AS REQUIRED
- ADD WASTE WATER DUMP, WATER STERILIZER, HEATERS, BLANKETS
- ADD 2 PLSS UNITS

AAP-3A DERIVED LOGISTIC CSM WEIGHT STATEMENT

CM			13091
EMPTY		11620	
NON-EXPENDABLE LOAD		1170	
CREW SYSTEMS	1039		
RCS RESIDUAL	45		
ECS	86		
EXPTS, SUPPORT	-		
EXPENDABLE LOAD		301	
RCS	225		
ECS	76		
SM			12303 (+PROPELLANTS)
EMPTY		11143	
NON-EXPENDABLE LOAD		793	
RCS RESIDUAL	208		
SPS RESIDUAL	562		
CRYO RESIDUAL	23		
EXPENDABLE LOAD		367 (+PROPELLANTS)	
SPS	}	PROPELLANTS FUNCTION OF ALTITUDE, INCLINATION	
RCS			
O ₂			337
H ₂			30
N ₂		0	
AAP-3A DERIVED LOGISTIC CSM WEIGHT			25394 (+PROPELLANTS)

FIGURE 11

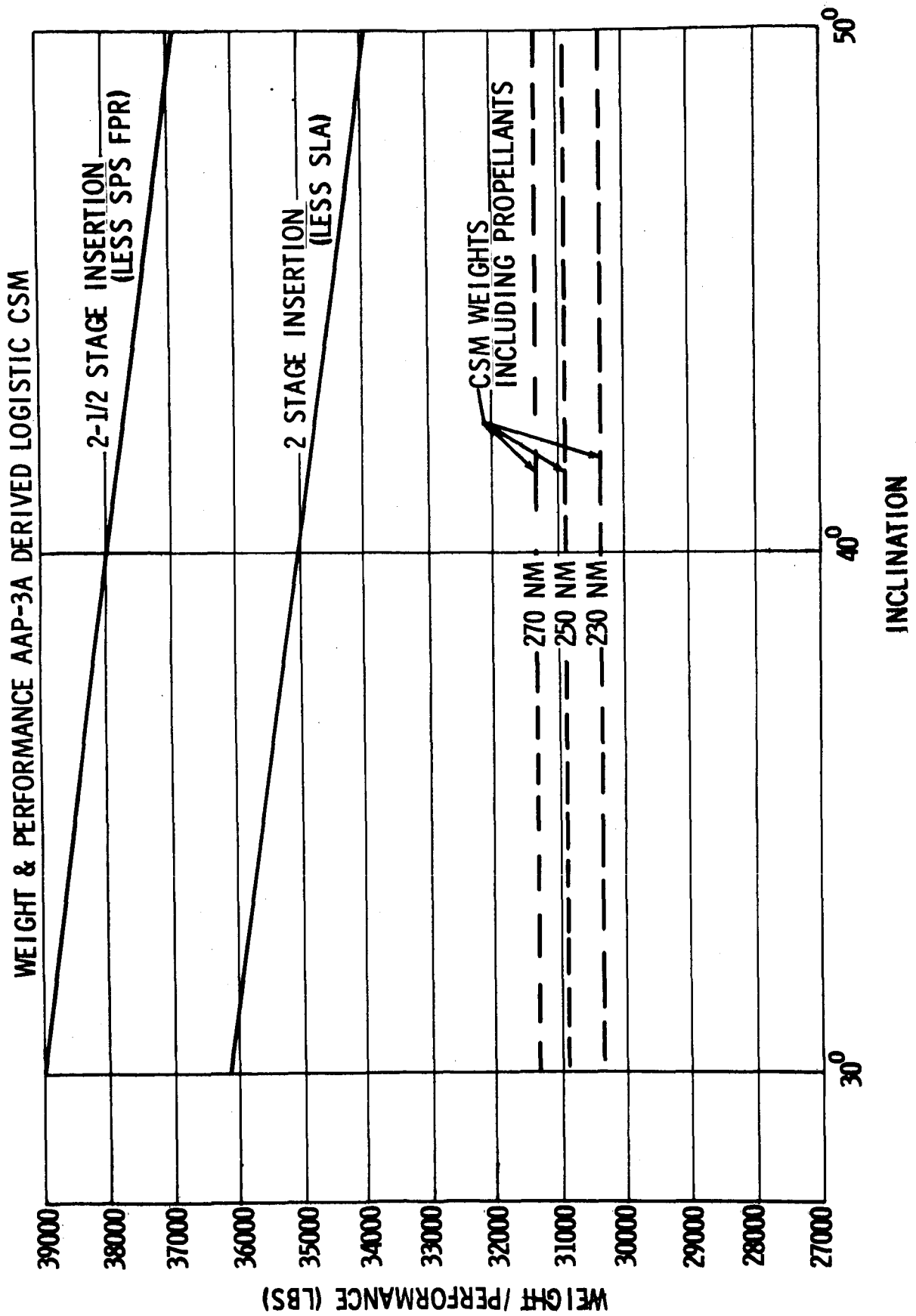


FIGURE 12

AAP-3A DERIVED LOGISTIC CSM WEIGHT & PERFORMANCE

CSM WT. WITHOUT PROPELLANTS 25,394				MODE	2 STAGE			2 1/2 STAGE		
				INCLINATION	30°	40°	50°	30°	40°	50°
FINAL ALTITUDE	PROPELLANTS		CSM	CAPABILITY*	36150	35050	33950	39000	38000	36900
	SPS	RCS	INSERTED WT							
230 NM	2716	2227	30337		+5813	+4713	+3613	+8663	+7663	+6563
250 NM	3120	2382	30896		+5254	+4154	+3054	+8104	+7104	+6004
270 NM	3479	2499	31372		+4778	+3678	+2578	+7628	+6628	+5528

* 2 STAGE LAUNCH VEHICLE CAPABILITY HAS SLA SUBTRACTED

2 1/2 STAGE LAUNCH VEHICLE HAS 1150 LB SPS FPR SUBTRACTED

FIGURE 13

BLOCK II DERIVED LOGISTIC CSM

FUNCTIONS

- SINGLE RENDEZVOUS
- DE-ORBIT BACKUP OF SPS BY RCS
- FOUR-DAY INDEPENDENT CAPABILITY
 - POWER
 - BLOCK II FUEL CELLS FOR ASCENT AND RENDEZVOUS
 - BATTERIES FOR DE-ORBIT
 - LIFE SUPPORT
 - FOOD, LIOH, ETC. FOR 4 DAYS
 - PURE O₂ ATMOSPHERE
 - WATER FROM FUEL CELLS
 - GASEOUS O₂ SUPPORT FOR DE-ORBIT
- OWS SUPPLIES ALL CSM IN-ORBIT REQUIREMENTS
 - POWER (1-2 KW)
 - CONTINUOUS HEATER AND SYSTEM STANDBY
 - INTERMITTENT CSM STATUS MONITORING (INSTRUMENTATION, C & D, TELEMETRY)
 - LOW-DUTY-CYCLE OPERATION OF SUBSYSTEMS WHICH EXHIBIT DEGRADATION WITH NON-OPERATION
 - ATMOSPHERE CIRCULATION AND LEAKAGE MAKEUP WHEN CSM IS OPEN TO OWS
 - CRITICAL CSM SUBSYSTEM WARNING PANEL
- CSM ORBITAL LIFETIME
 - INDEPENDENT OF CSM CONSUMABLES
 - DEPENDENT ON SYSTEM DEGRADATION, WEAROUT

BLOCK II KIT MODIFICATION SUMMARY

- REMOVE 1 BLOCK II O₂ AND 1 BLOCK II H₂ TANKS
- ADD 2 RCS TANK FARMS
- ADD RETURN BATTERY AND REPLACE RE-ENTRY PRYO BATTERY
- ADD 2 PLSS UNITS
- REMOVE SPS STORAGE TANKS & 1 HELIUM TANK
- REMOVE LM TRANSPONDER AND HIGH GAIN ANTENNA
- ADD INSTRUMENTATION, WIRING, REGULATORS, DISPLAYS AND CONTROLS AS REQUIRED
- ADD HEATERS, BLANKETS

AAP-3A KITS NOT INCLUDED

- AAP CRYO TANKS
- CONTROLS FOR 2 GAS ATMOSPHERE
- UPRATED FUEL CELLS
- WASTE WATER & URINE DUMP
- WATER STERILIZER & H₂ SEPERATOR

FIGURE 14

BLOCK II DERIVED LOGISTIC CSM WEIGHT STATEMENT

CM			13032
EMPTY		11561	
NON-EXPENDABLE LOAD		1170	
CREW SYSTEM	1039		
RCS RESIDUAL	45		
ECS	86		
EXPTS, SUPPORT	-		
EXPENDABLE LOAD		301	
RCS	225		
ECS	76		
SM			9918 (+PROPELLANTS)
EMPTY		8774	
NON-EXPENDABLE LOAD		777	
RCS RESIDUAL	208		
SPS RESIDUAL	562		
CRYO RESIDUAL	7		
EXPENDABLE LOAD		367 (+PROPELLANTS)	
SPS	}	PROPELLANTS	FUNCTION OF ALTITUDE, INCLINATION
RCS			
O ₂		337	
H ₂		30	
BLOCK II DERIVED LOGISTIC CSM WEIGHT			22950 (+PROPELLANTS)

FIGURE 15

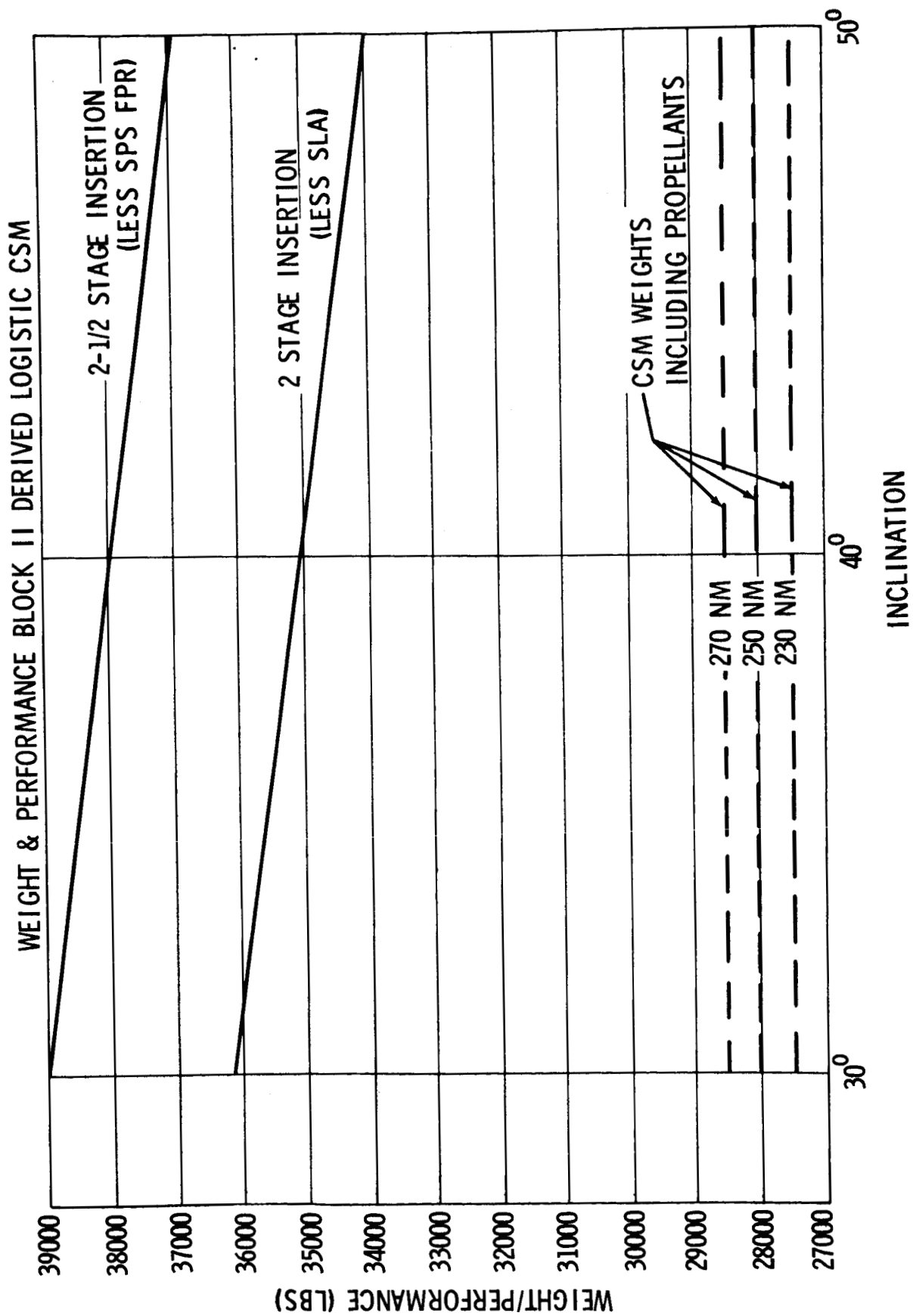


FIGURE 16

BLOCK II DERIVED LOGISTIC CSM WEIGHT & PERFORMANCE

CSM WT. WITHOUT PROPELLANTS				MODE		2 STAGE			2 1/2 STAGE		
22,950				INCLINATION		30°	40°	50°	30°	40°	50°
FINAL ALTITUDE	PROPELLANTS	CSM		CAPABILITY *		36150	35050	33950	39000	38000	36900
	SPS	RCS	INSERTED WT								
230 NM	2463	2061	27474			+8676	+7576	+6476	+11526	+10526	+9426
250 NM	2837	2209	27996			+8154	+7054	+5954	+11004	+10004	+8904
270 NM	3165	2326	28441			+7709	+6609	+5509	+10559	+9559	+8459

* 2 STAGE LAUNCH VEHICLE CAPABILITY HAS SLA SUBTRACTED

2 1/2 STAGE LAUNCH VEHICLE HAS 1150 LB SPS FPR SUBTRACTED

FIGURE 17

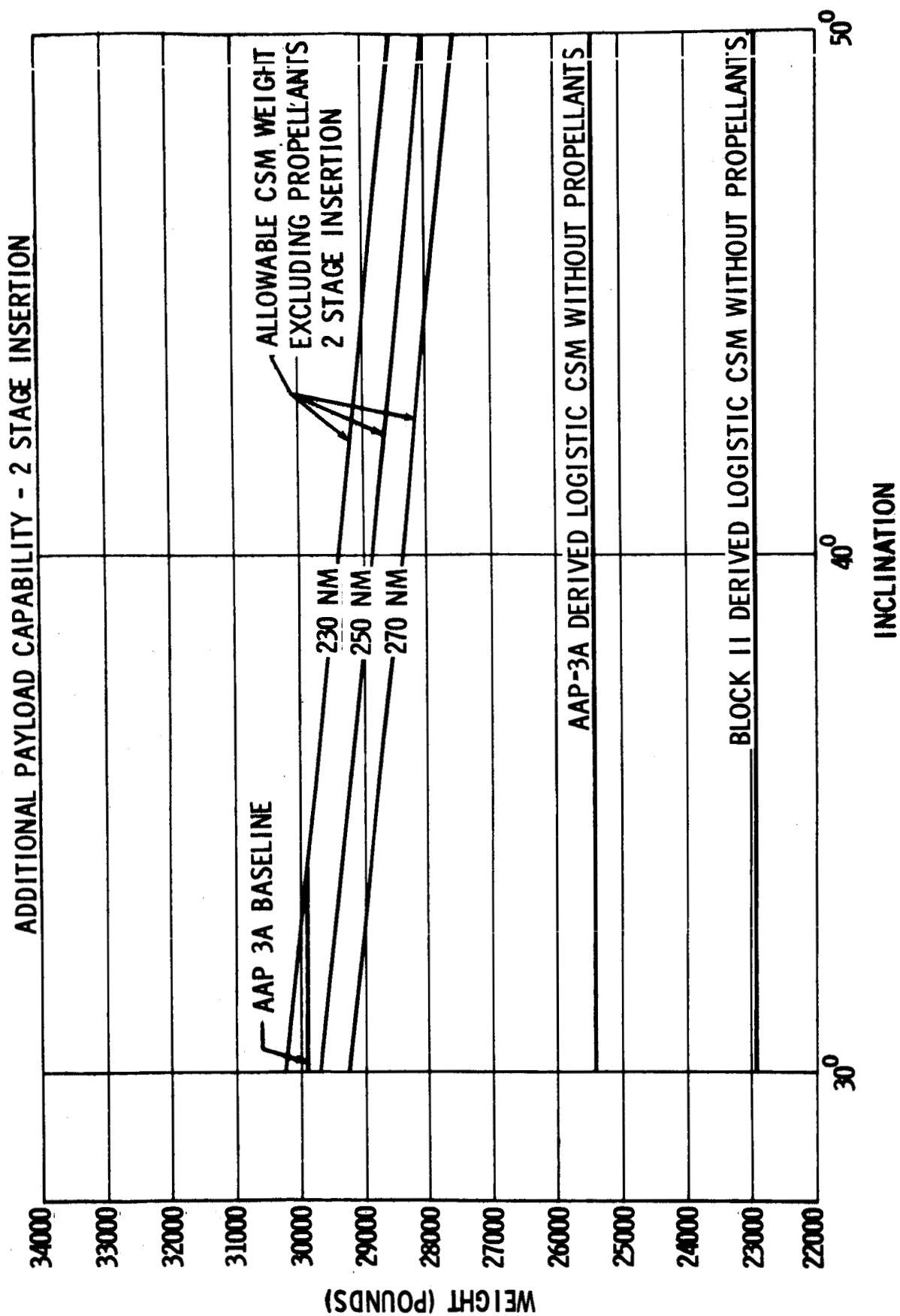


FIGURE 18

MAXIMUM RETURN PAYLOAD CAPABILITIES

- | | |
|-----------------------------------|----------|
| - AAP-3A BASELINE & LOGISTIC CM'S | 981 LBS |
| - BLOCK II DERIVED LOGISTIC CM | 1040 LBS |

REDUCTIONS TO LIFT-OFF WEIGHT TO OBTAIN RECOVERY WEIGHT WITHOUT PAYLOAD

- REDUCE CREW SYSTEMS LOAD TO 830 LB
- ELIMINATE ECS NON-EXPENDABLE LOAD
- ELIMINATE EXPERIMENTS
- ELIMINATE FORWARD HEAT SHIELD (-286 LB)
- ELIMINATE DOCKING MECHANISM (-139 LB)
- USE RCS (-225 LB)
- ABLATE HEAT SHIELD (-127 LB)

COMPARE TO 13000 LB RECOVERED WEIGHT CONSTRAINT TO OBTAIN ALLOWABLE PAYLOAD

(FOR HIGH-ALTITUDE ABORT, SAME CONSTRAINT LIMITS CM LIFT-OFF WEIGHT TO 13,500 LBS. 13000 INCLUDES WEIGHT OF CHUTES, AND GIVES FACTOR OF SAFETY OF 1.36 ON CM STRUCTURE FOR HIGH-ALTITUDE ABORT WITH ONE DROGUE, THREE MAIN CHUTE DEPLOYMENT)

FIGURE 19

BELLCOMM, INC.

Subject: CSM Configurations to
Support Saturn V
Workshops

From: J. J. Gabrik
W. W. Hough

Distribution List

NASA Headquarters

Messrs. H. Cohen/MLR
P. E. Culbertson/MLA
J. H. Disher/MLD
J. A. Edwards/MLO
L. K. Fero/MLV
J. P. Field, Jr./MLP
T. A. Keegan/MA-2
C. W. Mathews/ML
M. Savage/MLT

Bellcomm

Messrs. A. P. Boysen
D. R. Hagner
W. C. Hittinger
B. T. Howard
J. Z. Menard
I. M. Ross
R. L. Wagner
Div. 101 Supervision
Div. 103
Dept. 2015 Supervision
All Members Dept. 1021, 1022, 1024
Department 1023
Central File
Library